PB-227 092

# PARTICULATE SAMPLING BY ADHESIVE-COATED MATERIALS

Dean L. Faulkner, et al

Cincinnati City Division of Air Pollution Control

Prepared for:

Public Health Service

1 October 1968

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 227 092

# PROGRESS REPORT NO. 4

# PARTICULATE SAMPLING BY ADHESIVE-COATED MATERIALS

BY

DEAN L. FAULKNER
CHARLES E. SCHUMANN
CHARLES W. GRUBER

WORK PERFORMED UNDER
U. S. PUBLIC HEALTH SERVICE RESEARCH GRANT

PROJECT GRANT NO. AP 00370-04

OCTOBER 1, 1968

DIVISION OF AIR POLLUTION CONTROL
DEPARTMENT OF SAFETY
CITY OF CINCINNATI, OHIO



Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

50

# I. PREFACE

"Particulate Sampling by Adhesive-Coated Materials" is a report prepared by the City of Cincinnati, Division of Air Pollution Control, to summarize the results obtained during the fourth year of work on the U. S. Public Health Service Research Grant No. AP 00370-04. During this fourth year, due to the delay in receiving funds and consequently staffing, the first six months of the fourth year were lost. Research was conducted only from April 1, 1968 through September 30, 1968, a period of six months.

A brief summary of past accomplishments and consideration of future developments will comprise the first part of this report. The second part will deal with a limited area survey in an industrial community. The third part will cover the relationship between the adhesive impactor and dust fall measurement techniques. This study is a continuation of work which was recorded in the supplemental data section of Progress Report No. 3, compiled by Bruce A. Steiner, Jr. Most of the data generated by Mr. Steiner's work will be used, in addition to new data.

## II. TABLE OF CONTENTS


| | | Page |
|---|---|---|
| I. | PREFACE | i |
| II. | TABLE OF CONTENTS | ii |
| III. | INDEX OF TABLES AND FIGURES | iii |
| IV. | INTRODUCTION | 1 |
| | A. Scope and Purpose | 1 |
| | B. Primary Objectives | 2 |
| | C. Phase Completion Schedule | 2 |
| V. | A LIMITED AREA SURVEY IN AN INDUSTRIAL COMMUNITY | 5 |
| | A. The Adhesive Impactor | 5 |
| | B. Planning the Survey | 5 |
| | C. Collection and Analysis | 7 |
| | D. Interpretation | 8 |
| | E. Reporting Data | 8 |
| | F. Conclusions | 8 |
| VI. | THE RELATIONSHIP BETWEEN THE ADHESIVE IMPACTOR METHOD AND DUST FALL MEASUREMENT TECHNIQUES | 11 |
| | A. Dust Fall Measurement Techniques | 11 |
| | B. Mechanics of the Adhesive Impactor Method | 11 |
| | C. Analysis and Evaluation of Data | 11 |
| VII. | REFERENCES | 13 |
| VIII. | APPENDIX | 14 |
| | A. Data Tables 1 through 8 | |
| | B. Figures 1 through 23 | |

## III. INDEX OF TABLES AND FIGURES


FIGURE 1. Adhesive Impactor
FIGURE 2. Gruber Particle Comparator
FIGURE 3. Incinerator Testing with Adhesive Impactor
FIGURE 4. Part of Industrial Complex
FIGURE 5. Map Diagram of Industrial Community
FIGURE 6. Bracket Holding Adhesive Impactor
FIGURE 7. Adhesive Impactor Mounted on Pipe Stand

TABLE 1. Industrial Community Particulate Totals

FIGURE 8. Atmospheric Standards

TABLE 2. Control Station Compared with Other Sampling Stations
TABLE 3. Percent of Directional Loading.

FIGURE 9. Industrial Community Wind Rose
FIGURE 10. Dust Fall Container and Adhesive Impactor
FIGURE 11. Map Diagram of City of Cincinnati

TABLE 4. August, 1967 - Totals - Wind-blown v. Settleable Particulates
TABLE 5. September, 1967 - Totals - Wind-blown v. Settleable Particulates
TABLE 6. May, 1968 - Totals - Wind-blown v. Settleable Particulates
TABLE 7. June, 1968 - Totals - Wind-blown v. Settleable Particulates
TABLE 8. July, 1968 - Totals - Wind-blown v. Settleable Particulates

FIGURE 12. August, 1967 - Wind-blown v. Settleable Particulates - by Individual Station
FIGURE 13. September, 1967 - Wind-blown v. Settleable Particulates - by Individual Station
FIGURE 14. May, 1968 - Wind-blown v. Settleable Particulates - by Individual Station
FIGURE 15. June, 1968 - Wind-blown v. Settleable Particulates - by Individual Station
FIGURE 16. July, 1968 - Wind-blown v. Settleable Particulates - by Individual Station

FIGURE 17. August, 1967 - Wind-blown v. Settleable Particulates - by Area Class
FIGURE 18. September, 1967 - Wind-blown v. Settleable Particulates - by Area Class

FIGURE 19. May, 1968 - Wind-blown v. Settleable Particulates - by Area Class
FIGURE 20. June, 1968 - Wind-blown v. Settleable Particulates - by Area Class
FIGURE 21. July, 1968 - Wind-blown v. Settleable Particulates - by Area Class

FIGURE 22. 1967 - Wind-blown v. Settleable Particulates - Weather Data Graph
FIGURE 23. 1968 - Wind-blown v. Settleable Particulates - Weather Data Graph

## IV. INTRODUCTION

### A. Scope and Purpose

The first part of Progress Report No. 3 will be used to restate some important information and the report will be referred to throughout this work. In this way, the entire Progress Report No. 3 will not have to be summarized in Progress Report No. 4.

Atmospheric particulates are usually classed as settling or non-settling particulates. The settling class is largely composed of particles greater than 100 microns in diameter. The non-settling class is considered to be smaller than 20 microns in diameter. This leaves a transitional group of particles, ranging from approximately 20 microns to 100 microns in diameter. This transitional group of particles can fall into either the settling or non-settling class depending upon surface winds and other weather factors at the time of emission. It is this transitional group of airborne particulate matter that is responsible for a large portion of air pollution, particularly in citizen complaint situations.

The City of Cincinnati, Division of Air Pollution Control, has been studying the application of adhesive-coated materials since 1954, in an effort to find a simple and rapid method of estimating the concentration and direction of wind-blown nuisance particulates and to evaluate source emissions.

The adhesive impactor, which consists of an adhesive-coated material wrapped, sticky side out, around and over the top of a 2-3/4" diameter wide mouth jar mounted upside down (Figure 1) has been used in two ways. First, the sampler is placed in an open area approximately ten feet above the ground for seven days. North direction is marked on the jar and the concentration of wind-blown particulates larger than 20 microns is determined for eight directions and the top by the use of the Gruber Comparator, which contains photographic standards of known concentrations of particles (Figure 2). The results from each direction, or the total particle loading, can be compared with other adhesive samplers in various locations. A variation of the above technique is the use of adhesive samplers in nuisance complaint situations where the source of excessive dusts is unknown. The samplers can be placed at random in the area or they can be triangulated around a suspected source. The source of emissions can often be pinpointed by the directional indicating capability of the adhesive-coated cylinders.

A second way in which the adhesive-impactor can be used is for the estimation of nuisance particle emissions from incinerators. The samplers are placed in a horizontal position over the stacks (Figure 3) or through a test port provided in the stack and the

particle concentrations are counted microscopically. The number of particles per square inch (greater than 20 microns) located on the adhesive surface is then multiplied by the area of the stack to give total particles emitted per minute. The Cincinnati Division of Air Pollution Control has established a code based upon the above method to regulate incinerator particulate emissions.

Application was made to, and accepted by, the U. S. Public Health Service, for a grant which would make it possible for certain standard criteria to be developed. This report will cover past research with greatest emphasis on the fourth period of work.

## B. Primary Objectives.

The primary objectives (re-stated from Progress Report No. 3) of the Project are:

1) Determine the adhesive material(s) best suited for the method.

2) Determine the mechanism(s) of particle collection.

3) Determine the environmental and mechanical factors affecting the collection efficiency.

4) Devise a relatively simple and rapid means of evaluating the samples collected.

5) If practical, identify and classify particles collected.

6) Apply the criteria developed and the results obtained above, to one or more area surveys.

7) Improve the prototype model of a source sampling device which utilized a continuously moving adhesive-tape for particle collection.

## C. Phase Completion Schedule

The following information has been taken from Progress Report No. 3, with additions which will bring the schedule up to date.

PHASE 1. The procurement of major equipment and materials necessary to start the project. This phase, except for the wind tunnel and aerosol generator (Phase 7) was initiated on December 15, 1964 and completed on February 1, 1965.

PHASE 2. Investigate sources of adhesive materials, procuring samples of adhesive-coated tapes, and discussions with adhesive manufacturers. Phase 2 also began on December 15, 1964 and was completed on April 30, 1965.

PHASE 3. Field evaluation of adhesive materials in terms of relative atmospheric particle collection efficiency during both the cold (winter) and warm (summer) seasons was completed. Also, the effect of the sampler surface geometry on the relative collection efficiency of the best adhesive-coated material. Testing in the cold season started January 1, 1965, and ended May 15, 1965. Testing in the warm season began on May 15, 1965, and was completed on September 1, 1965. Testing of the sampler surface geometry was initiated on May 15, 1965, and completed by December 1, 1965.

PHASE 4. Field evaluation of adhesive materials for source (incinerator) sampling. Field evaluation began on May 15, 1965 and was completed by December 1, 1965.

PHASE 5. Develop a laboratory test to evaluate the potential atmospheric collection efficiencies of adhesive materials. The test was developed and evaluated from February 15, 1965, to June 15, 1965. No more work is anticipated on this phase.

PHASE 6. Develop criteria for the most suitable adhesive to be used in atmospheric testing and in source (incinerator) testing. This phase was initiated on July 1, 1965 and completed in June, 1966.

PHASE 7. Wind tunnel and aerosol generator. The design, procurement of materials and construction of the wind tunnel was started in May, 1965, and was completed by March, 1966. Actual testing under controlled conditions was run from March, 1966, to June, 1967.

PHASE 8. Develop a simplified means of quantitating particle collection. Also included in this phase is the identification and qualification of the collected particles. The development of a simplified means of quanitification was started in May, 1965, and completed in October, 1966. The identification and qualification of collected particles was initiated on July 1, 1965, and was completed on July 1, 1966.

PHASE 9. Refine and field test "tape sampler" for source (incinerator) testing. Time will not permit the initiation of research on this phase during the grant period, ending September 30, 1969.

PHASE 10. Conduct limited area survey to confirm previous findings. Field work on the first area survey, the relationship between the adhesive impactor and dust fall measurement techniques, was started on May 28, 1968, and was completed on July 30, 1968. Field work on the second area

survey, a limited area survey in an industrial community, was started on July 22, 1968, and was completed on September 2, 1968. At least one more limited area survey is planned for the next grant period.

PHASE 11. Application of the adhesive impactor method to emission sources other than incinerators. This would include coal fired heat and power generating plants. Preliminary investigation has been started.

PHASE 12. Preparation of annual report and technical papers. This phase includes four annual project reports and several technical papers.

## V. A LIMITED AREA SURVEY IN AN INDUSTRIAL COMMUNITY

The primary goal for this reporting period, April 1, 1968 through September 30, 1968, was to conduct a limited area survey and confirm previous findings relating to the adhesive impactor atmospheric sampling method. The first survey to be discussed will be a limited area survey in an industrial community.

The purpose in selecting the municipality of St. Bernard for study lies in the fact that many complaints are registered every year due to smoke, odors, fumes, dust and fly ash. A major portion of this air pollution is caused by the many industrial processes that are continuously taking place (Figure 4). Within a one-half mile radius one will find a large soap and detergent manufacturing company, a margerine processing company, an animal fat rendering plant, two fertilizer manufacturers, three major chemical manufacturing plants, a brass foundry, a municipal incinerator, several coal-fired boiler plants, a scrap metal company, two railroads, and an interstate highway. Residential areas surrounding this industrial complex are subjected to varying amounts of air pollutants from these multiple sources.

The purpose of this survey was to pinpoint major air pollution sources and their relative contributions to overall pollution levels throughout the area.

The Recommended Standard Method for measuring Wind-Blown Nuisance Particles, developed in Progress Report No. 3 will be used in presenting this section of the report.

### A. The Adhesive Impactor

The adhesive impactor is a wide mouth glass jar, 2-3/4" in diameter and 3-3/8" in height with a strip of Fasson Products R-135 Pli-A-Print (adhesive-coated paper) 1" x 6", mounted (sticky side up) over the top of the inverted glass jar and a strip of the same adhesive material wrapped around the side of the inverted glass jar (sticky side out) (Figure 1).

### B. Planning the Survey

1) Classification of the Area. Each sampling station was not classified since eleven out of the fourteen stations were located (primary classification) in Zone F - Industrial, with air pollution potential.

2) Selection of the Site for the Sampling Station. The sampling stations were selected in order to enable the adhesive impactor to collect the wind-blown particles and not be unduly affected by interference from buildings or other higher ob-

jects or structures. Accessibility and security (freedom from tampering) were also factors of major importance.

The following specific recommendations (from Progress Report No. 3) were used as a guide in the selection of suitable sites.

1. The adhesive impactor shall be a minimum of 8 feet and a maximum of 50 feet above the ground, or 5 feet minimum above any other surface, such as a roof. Higher objects such as parapets, signs, penthouses, etc. must not be more than 30° from the horizontal, as measured in 4. below.

2. Ten to twelve feet up the side of a utility pole and two feet away from the pole in an open area or on the roof of low buildings are most favorable positions for adhesive impactors because of their accessibility and security.

3. Care should be taken to avoid undue influence from chimneys on the building of the sampling station. Wherever possible, set the adhesive impactor more than ten stack lengths from an operating stack and upwind (prevailing).

4. When higher buildings in the immediate vicinity cannot be avoided the top of any building should not be more than 30° above an adhesive impactor. That is, a line drawn from the building should form not more than a 30° angle with the horizontal.

Fourteen sampling stations were set up throughout the St. Bernard area, one of which was placed in a residential community 5 miles away, as a control. The station numbers can be located on the map diagram (Figure 5), and are outlined below:

1. Located on a residential street ten feet up a utility pole on a bracket (Figure 6) two feet from the pole.

2. Located south of a six lane interstate highway (I-75) ten feet up a utility pole and on a bracket two feet from the pole.

3. Located north of a six lane interstate highway (I-75) ten feet up a utility pole and on a bracket two feet from the pole.

4. Located southeast of a large soap and detergent manufacturing company (on property owned by the company) ten feet up a utility pole and on a bracket two feet from the pole.

5. Located southwest of a large soap and detergent manufacturing company (on property owned by the company) ten feet up a utility pole and on a bracket two feet from the pole.

6. Located in the parking lot of a chemical manufacturing company ten feet up a utility pole and on a bracket two feet from the pole.

7. Located in the rear of the chemical plant mentioned in Item 6 on a tower 30 feet from the ground attached to a stationary length of water pipe.

8. Located on the roof (approximately 20 feet from the ground) of a chemical sales company attached to a stationary length of water pipe.

9. Located northeast of a large soap and detergent manufacturing company (on property owned by the company) ten feet up a utility pole on a bracket two feet from the pole.

10. Located northwest of a large soap and detergent manufacturing company (on property owned by the company) ten feet up a utility pole on a bracket two feet from the pole.

11. Located on the corner of two residential streets ten feet up a utility pole on a bracket two feet from the pole.

12. Located in the parking lot of a chemical manufacturing company ten feet up a utility pole on a bracket two feet from the pole.

13. Located at the rear of a trucking company on the Mill Creek ten feet from the ground attached to a stationary length of water pipe.

14. Located in a residential area (College Hill) on the roof of the fire house attached to a stationary length of water pipe. This served as the control sampler.

3) Number and Spacing of Stations. The number and spacing of the stations was governed by the purpose of the survey, which was to attempt to pinpoint major (suspected) air pollution contributors. Enough sampling stations were placed throughout the approximately one square mile area in order to show the cause of air pollution (dust from roadways, fly ash from stacks, etc.) and to show who was causing the air pollution.

4) Maintenance of the Site and Length of Sampling Period. The fourteen test sites were continually checked for six weeks, from July 22, 1968 through September 2, 1968. Each week the adhesive impactor was removed and replaced by a fresh one.

## C. Collection and Analysis

The following procedure was followed for the collection and analysis of adhesive impactors:

1) The inverted glass jar with the adhesive-coated material over the top and around the sides was mounted on its appropriate jar lid. The jar lid was then mounted to a wooden bracket which was attached to a utility pole (Figure 6). In some cases it was necessary to mount the lid to a water pipe flange which was attached to a stationary length of water pipe (Figure 7).

2) The adhesive impactors were prepared in advance and the release liners were removed from the adhesive at the start of the test period.

3) A compass was used to determine north direction which was marked on the sampler with a permanent type ink marker.

4) After exposure, the impactors were placed in a carrying case, each in a fixed position, to be adequately protected from extraneous materials during transport from the laboratory to the field and from the field back to the laboratory.

## D. Interpretation

When examining the individual impactors comparison was made between the concentration collected in each of eight directions and the top. As a group, the samplers were compared by total count and directional counts (see Table 1). The concentration of particles per square inch greater than twenty microns is determined for the eight compass directions and the top of the sampler by visual comparison with photographic standards of known concentrations of particles (Figure 8). The analysis of the adhesive impactors was performed on the Gruber Comparator (Figure 2).

The collected particles were also subjected to microscopic count in order to recheck the results obtained on the Gruber Comparator. The average percent error was less than ± 20%, which is the expected error when estimating directional loadings by this method.

## E. Reporting Data

The data for each impactor was recorded every week for each of eight directions and the top as particles per square inch. Both visual and microscopic counts were made. At the end of the six-week testing period the total particles per square inch for each impactor from the eight directions and the top were recorded.

## F. Conclusion

Table 1 was prepared for the six week testing period to show the test sites and the total particle count for eight directions and the top (particles per square inch). The test sites can be located on the map diagram (Figure 5). By simply referring to Table 1 and Figure 5 it becomes evident that the goal to pinpoint the major

air pollution offenders has been accomplished. It is possible to see who is emitting particulate matter and how much. The power plants and incinerator are emitting the greatest amount of particulate matter. There was also a high percentage of particulate matter on the adhesive impactors (on the directions facing the road) which were stationed on both sides of I-75 (locations 2 and 3). The above conclusions were reached with economy of time and money and provide visible evidence for corrective action.

For even further clarification and evaluation of this industrial community, Table 2 has been prepared. Here the control station (Station 14) which is located in a residential community 5 miles away, is compared with the other thirteen testing sites in the industrial community. The control station had an average of 700 particles per square inch per week. Sampling Stations 1 and 11 were the two residential areas within the industrial community and they averaged 43% and 114% dirtier than the control station, or 1.4 and 2.1 times dirtier than the control station. The station in which the heaviest loadings were found (Station 8) was 757% dirtier or 8.6 times dirtier than the control station. Percentages for all of the stations are found in Table 2.

Sampling Stations 2 and 3 were of particular interest as they presented the opportunity to study the effects that an interstate highway (I-75) would have on the adhesive impactors. It should be noted that some of the particulate matter collected was emitted from the city incinerator, but most of the particulate matter was probably swept into the atmosphere by speeding autos and trucks on the six lane interstate highway.

The following chart shows the percent of particulate loading from eight directions for both sides of Interstate Highway 75.

| STATION 2 | | STATION 3 | |
|---|---|---|---|
| N | 26% | N | 7% |
| S | 7% | S | 14% |
| NE | 18% | NE | 7% |
| SW | 5% | SW | 19% |
| NW | 22% | NW | 10% |
| SE | 5% | SE | 14% |
| W | 10% | W | 22% |
| E | 7% | E | 7% |

This data indicates that a considerable amount of particulate matter is moved from the highway and into the atmosphere.

When dealing with airborne particulate matter, one of the most important factors to take into consideration is the wind direction. Table 3 has been prepared in order to show the percent of loading from each direction for the 14 test sites. At the bottom of the table the prevailing wind directions are also represented in percent form. Any percent of loading can be compared with the percent of prevailing wind from the same direction. To go a step further, the percentages for the wind direction are presented in the form of a wind rose (Figure 9). The wind rose is also found in the center of the "Bulls Eye" on Figure 5, and it compares to the particle loading vectors which proves that wind direction definitely affects particle loading at the various directions.

## VI. THE RELATIONSHIP BETWEEN THE ADHESIVE IMPACTOR AND DUST FALL MEASUREMENT TECHNIQUES.

The relationship between the adhesive impactor method and dust fall measurement techniques is the second limited area survey to be presented in this report. This represents one more effort to fulfill Phase 10. (Conduct a limited area survey to confirm previous findings)

### A. Dust Fall Measurement Techniques

The definition of dust fall is large particles of matter which settle rapidly near their point of irigin. They range in size from about twenty microns upwards. Measurements are made by placing wide-mouth plastic jars (Figure 10) at various points throughout the city (Figure 11) to obtain 30 day exposure samples. A weight analysis is made on each sample by distillation of the rain water and drying and weighing the residue. Results are expressed in terms of tons per square mile per month for each area where the jars are located.*

### B. The Mechanics of the Adhesive Impactor Method

The Recommended Standard Method for Measuring Wind-Blown Nuisance Particulates (developed in Progress Report No. 3) which was used in Section V of this report was also used in this survey.

During the months of August and September, 1967, and May, June and July, 1968, adhesive impactors were placed at the ten dust fall locations in Cincinnati. In each case, the impactor and the dust fall jar were located approximately ten feet apart and at the same height (Figure 10). Nine of the ten sites were located at roof top levels. The impactors were replaced weekly and particle counts were estimated with the Gruber Comparator for eight directions and the top and microscopic counts were also made to check the estimated results.

### C. Analysis and Evaluation of Data

Tables were prepared for the months of August and September, 1967, and May, June and July, 1968 (see Tables 4, 5, 6, 7, and 8) showing the testing sites, area classes, monthly total particulate counts for eight directions and the top (particles per square inch) and the total monthly dust fall figures (tons per square mile) for each station.

The data from the various tables was used in preparing several graphs. The first series of graphs (Figures 12, 13, 14, 15 and 16) are plots

*Taken directly from Air Quality Data Report, August, 1968, by Charles E. Schumann and Charles W. Gruber, Division of Air Pollution Control, City of Cincinnati.

of the total wind-blown particle counts vs. the total settleable particulates (by weight) for the months of August and September, 1967, and May, June and July, 1968. In general, there appears to be a good relationship, but some locations tend to deviate. An example is Figure 16, in which the Brighton Sampling Station tends to show the lease conformity. If the data is based on area classes (Figures 17, 18, 19, 20 and 21) rather than individual stations, the relationship is much more evident. Figure 17 is the best example of a direct relationship and Figure 21 shows the greatest deviation with Class F (Industrial, air pollution potential) varying more than the other classes.

It was mentioned earlier that the transitional group of particles, ranging from approximately 20 microns to 100 microns in diameter, can fall into either the settling or non-settling class depending upon surface winds and other weather factors. Some weather data has been presented in graphic form in Figures 22 and 23. The average number of particles per week that adhere to the impactor is larger when the average wind speed is high and the total rain fall (in inches per week) is low. Conversely, the average number of particles per week that adhere to the impactor is lower when the average wind speed is low and the total rain fall (in inches per week) is high.

After analysing the data collected over the period of five months, it is evident that there is a relationship between settleable and and wind-blown particulates. However, it must be pointed out that the measurement of wind-blown particulates by the adhesive impactor method is by particle count whereas the dust fall survey is by weight analysis. From research to date, the adhesive impactor method appears to be a better indicator of nuisance particulate levels than the dust fall method.

## VII. REFERENCES


1. Pritchard, W. L., Schumann, C.E., and Gruber, C.W., "Particulate Sampling by Adhesive-Coated Materials", third annual progress report USPHS Research Grant AP 00370-03. Division of Air Pollution Control, City of Cincinnati.

2. Pritchard, W.L., Schumann, C.E., and Gruber, C.W., "Particulate Sampling by Adhesive-Coated Materials", second annual progress report, USPHS Research Grant AP 00370-02. Division of Air Pollution Control, City of Cincinnati.

3. Pritchard, W.L., Schumann, C.E., and Gruber, C.W., "Particulate Sampling by Adhesive-Coated Materials", first annual progress report USPHS Research Grant AP 00370-01. Division of Air Pollution Control, City of Cincinnati.

4. Schumann, C.E., and Gruber, C.W., "Air Quality Data" 1967 Edition, Division of Air Pollution Control, City of Cincinnati.

5. Lemkuhl, R.B., "Intercommunity Air Pollution Control Program Activities for 1967". Division of Air Pollution Control, City of Cincinnati

## VIII. APPENDIX

DATA TABLES 1 THROUGH 8

FIGURES 1 THROUGH 23

FIGURE 1
ADHESIVE IMPACTOR

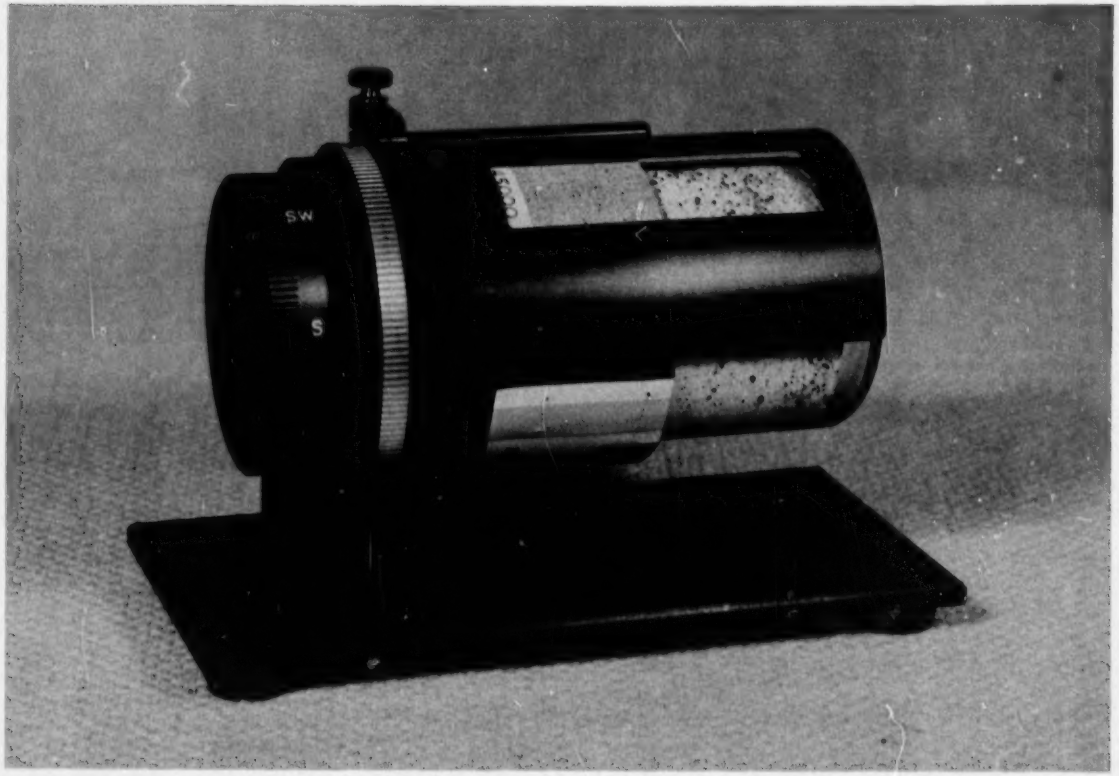



FIGURE 2

THE GRUBER PARTICLE COMPARATOR

Photograph Compliments of Research Appliance Co., Allison Park, Pa.

FIGURE 3

INCINERATOR TESTING WITH ADHESIVE IMPACTOR

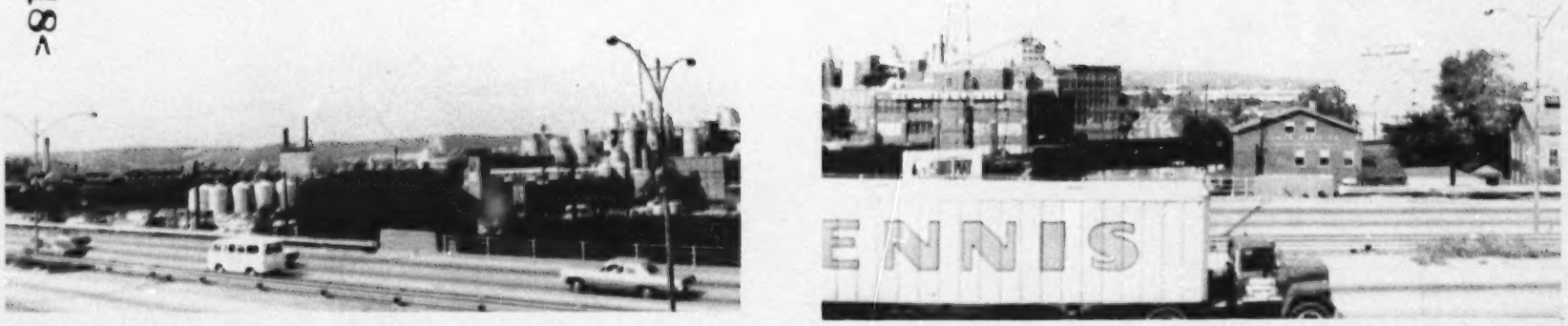



FIGURE 4

PART OF INDUSTRIAL COMMUNITY

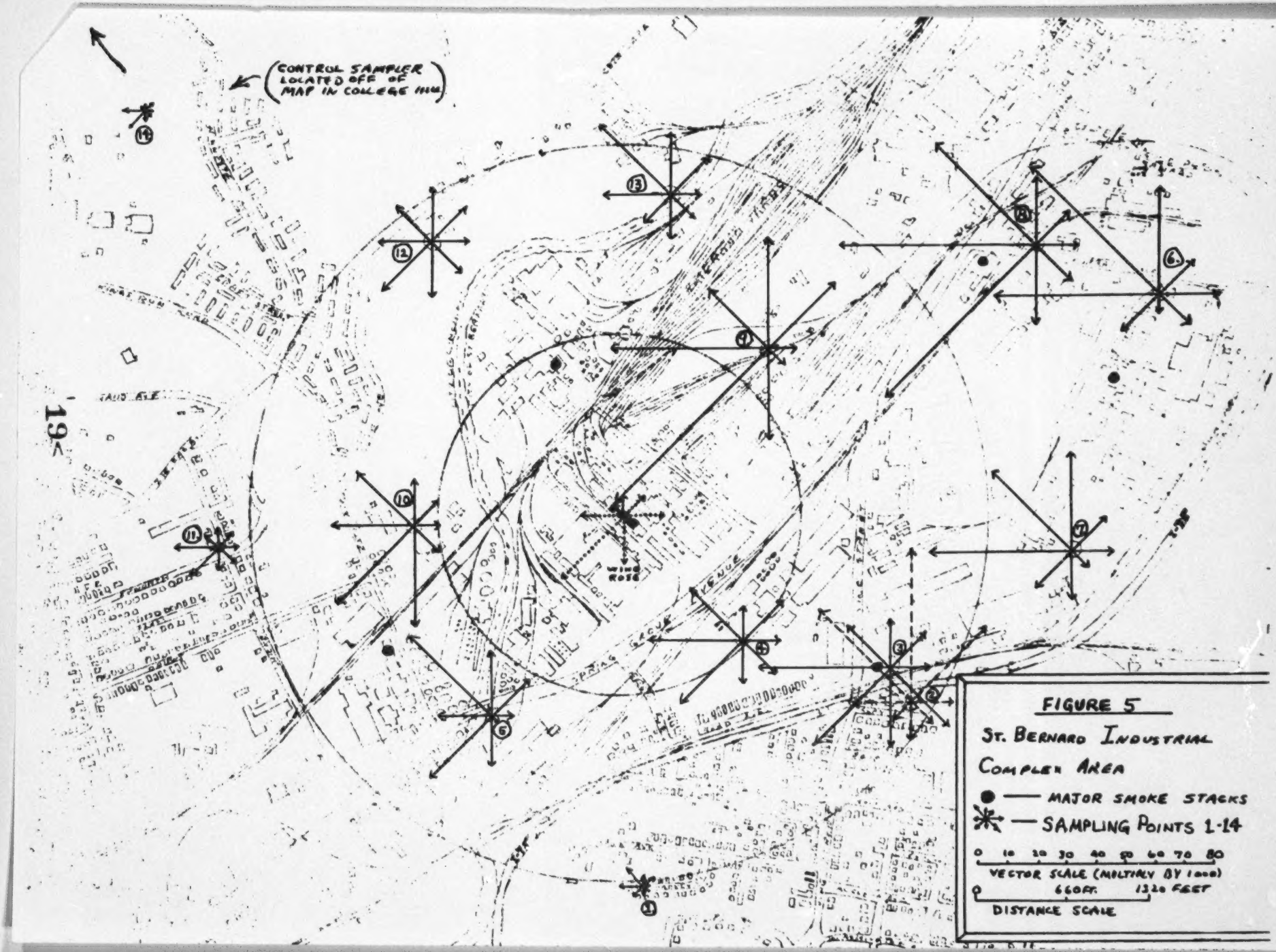

(CONTROL SAMPLER LOCATED OFF OF MAP IN COLLEGE HILL)
WIND ROSE
0 10 20 30 40 50 60 70 80
VECTOR SCALE (MULTIPLY BY 1000)
660 FT. 1320 FEET
DISTANCE SCALE

FIGURE 5

ST. BERNARD INDUSTRIAL COMPLEX AREA

● — MAJOR SMOKE STACKS

✳ — SAMPLING POINTS 1-14

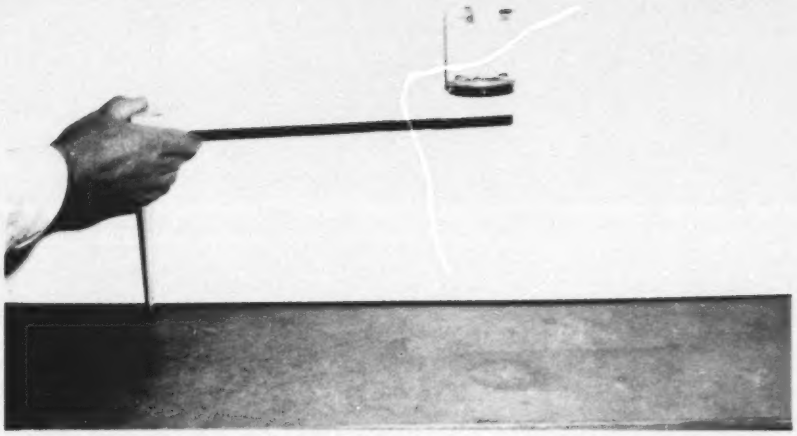


FIGURE 6

BRACKET HOLDING ADHESIVE IMPACTOR

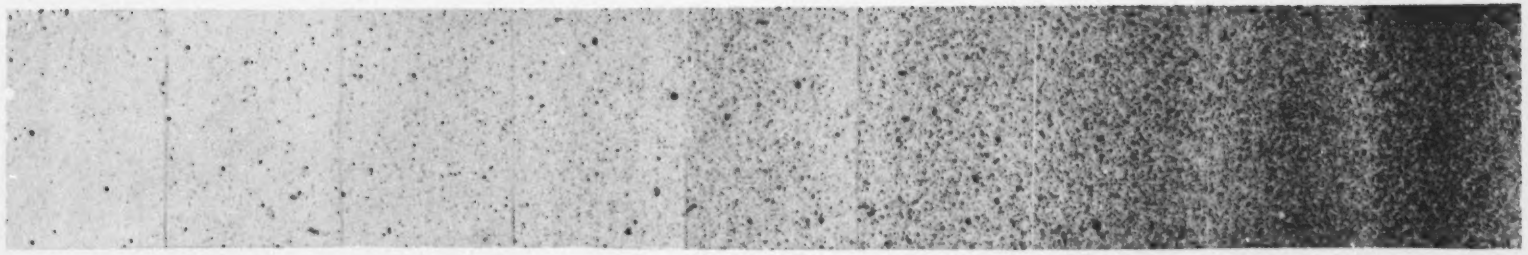
FIGURE 7

ADHESIVE IMPACTOR MOUNTED ON PIPE STAND

# TABLE 1

St. Bernard Project - July 22, 1968 through September 2, 1968

| LOCATION | NUMBER | N | NE | E | SE | S | SW | W | NW | TOTAL | TOP |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 particles per square inch) | | | | | | | | | |
| Harvey Court | 1 | 70 | 40 | 20 | 40 | 50 | 70 | 120 | 120 | 530 | 310 |
| I-75 (South) | 2 | 520 | 360 | 140 | 90 | 130 | 90 | 200 | 440 | 1970 | 400 |
| I-75 (North) | 3 | 150 | 150 | 140 | 280 | 280 | 380 | 450 | 210 | 2040 | 530 |
| Beech St.(East) Soap Co. | 4 | 110 | 190 | 170 | 150 | 150 | 310 | 410 | 260 | 1750 | 280 |
| Beech St.(West) Soap Co. | 5 | 220 | 190 | 80 | 40 | 180 | 300 | 190 | 250 | 1450 | 320 |
| Murray Ave., - Parking Lot | 6 | 340 | 160 | 200 | 150 | 80 | 180 | 570 | 610 | 2290 | 420 |
| Murray Ave. - Tower | 7 | 330 | 190 | 140 | 80 | 170 | 370 | 490 | 390 | 2160 | 360 |
| Murray Ave. - Roof | 8 | 240 | 150 | 140 | 180 | 280 | 730 | 680 | 490 | 2890 | 290 |
| June Street - Soap Co. | 9 | 370 | 320 | 90 | 80 | 310 | 750 | 540 | 290 | 2750 | 370 |
| Este Ave. - Soap Co. | 10 | 150 | 110 | 80 | 120 | 340 | 380 | 290 | 270 | 1740 | 410 |
| Epworth and Chickering | 11 | 50 | 80 | 80 | 70 | 80 | 140 | 140 | 70 | 710 | 340 |
| Chemical Co. - Este Ave. | 12 | 180 | 160 | 130 | 150 | 190 | 240 | 180 | 170 | 1400 | 280 |
| Transit Co. - Este Ave. | 13 | 210 | 180 | 110 | 120 | 150 | 130 | 230 | 330 | 1460 | 320 |
| Control - College Hill | 14 | 20 | 40 | 30 | 20 | 40 | 90 | 80 | 20 | 340 | 230 |




---PARTICLES PER SQUARE INCH --- OVER 20 MICRONS

CINCINNATI VISUAL STANDARDS A-3

3/67

CITY OF CINCINNATI AIR POLLUTION CONTROL AND HEATING INSPECTION

FIGURE 8

ATMOSPHERIC STANDARDS

# TABLE 2

INDUSTRIAL COMMUNITY STUDY

Particulate matter is represented as Particles per square inch per week

| Site No. | Particle Count for each Station | Particle Count for Control Station | DIFFERENCE | PERCENT DIFFERENCE | The number of times each station is dirtier than the Control Station |
|---|---|---|---|---|---|
| 1 | 1,100 | 700 | 300 | 43 | 1.4 |
| 2 | 4,000 | 700 | 3,300 | 471 | 5.7 |
| 3 | 4,200 | 700 | 3,500 | 500 | 6.0 |
| 4 | 3,600 | 700 | 2,900 | 414 | 5.1 |
| 5 | 3,000 | 700 | 2,300 | 328 | 4.3 |
| 6 | 4,800 | 700 | 4,100 | 586 | 6.9 |
| 7 | 4,500 | 700 | 3,800 | 543 | 6.4 |
| 8 | 6,000 | 700 | 5,300 | 757 | 8.6 |
| 9 | 5,700 | 700 | 5,000 | 714 | 8.1 |
| 10 | 3,600 | 700 | 2,900 | 414 | 5.1 |
| 11 | 1,500 | 700 | 800 | 114 | 2.1 |
| 12 | 2,900 | 700 | 2,200 | 314 | 4.1 |
| 13 | 3,000 | 700 | 2,300 | 328 | 4.3 |

TABLE 5

INDUSTRIAL COMMUNITY STUDY

Particle counts are represented in percent of loading from each direction.
Prevailing wind directions are also represented in percent form.

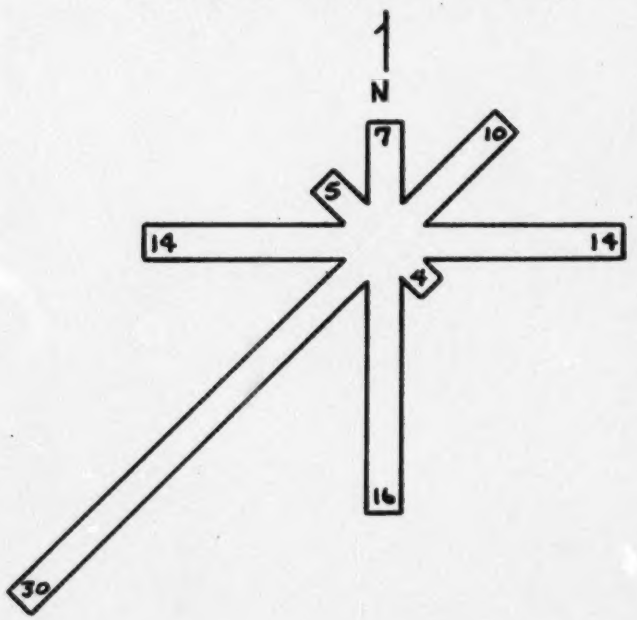
| LOCATION | NUMBER | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| Harvey Court | 1 | 13 | 8 | 3 | 8 | 9 | 13 | 23 | 23 |
| I-75 (South | 2 | 27 | 19 | 7 | 4 | 6 | 4 | 10 | 23 |
| I-75 (North) | 3 | 7 | 7 | 7 | 14 | 14 | 19 | 22 | 10 |
| Beech St. (East) | 4 | 6 | 11 | 10 | 8 | 8 | 18 | 24 | 15 |
| Beech St., (West) | 5 | 15 | 13 | 6 | 3 | 12 | 21 | 13 | 17 |
| Murray Ave. - Parking Lot | 6 | 15 | 7 | 9 | 6 | 3 | 8 | 25 | 27 |
| Murray Ave., - Tower | 7 | 15 | 9 | 6 | 4 | 8 | 17 | 23 | 18 |
| Murray Ave. - Roof | 8 | 8 | 5 | 5 | 6 | 10 | 25 | 24 | 17 |
| June Street | 9 | 13 | 12 | 3 | 3 | 11 | 28 | 20 | 10 |
| Este Avenue | 10 | 9 | 6 | 5 | 7 | 20 | 22 | 16 | 15 |
| Epworth and Chickering | 11 | 7 | 11 | 11 | 10 | 11 | 20 | 20 | 10 |
| Chemical Co. - Este Ave. | 12 | 13 | 11 | 9 | 11 | 14 | 17 | 13 | 12 |
| Transit Co. - Este Ave. | 13 | 14 | 12 | 8 | 8 | 10 | 9 | 16 | 23 |
| Control - College Hill | 14 | 6 | 12 | 9 | 6 | 12 | 25 | 24 | 6 |
| WIND ROSE | | 7 | 10 | 14 | 4 | 16 | 30 | 14 | 5 |

FIGURE 9

INDUSTRIAL COMMUNITY STUDY

# WIND ROSE

{The numbers represent the average per cent prevailing wind direction for the sampling period.



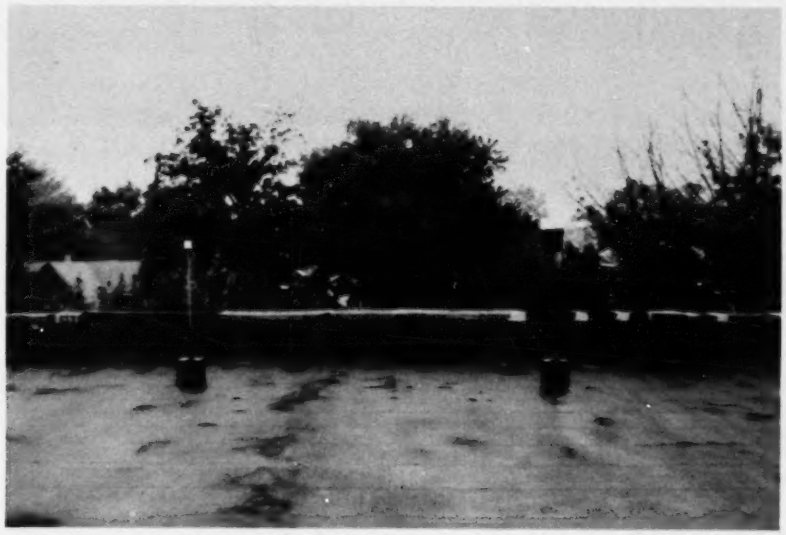
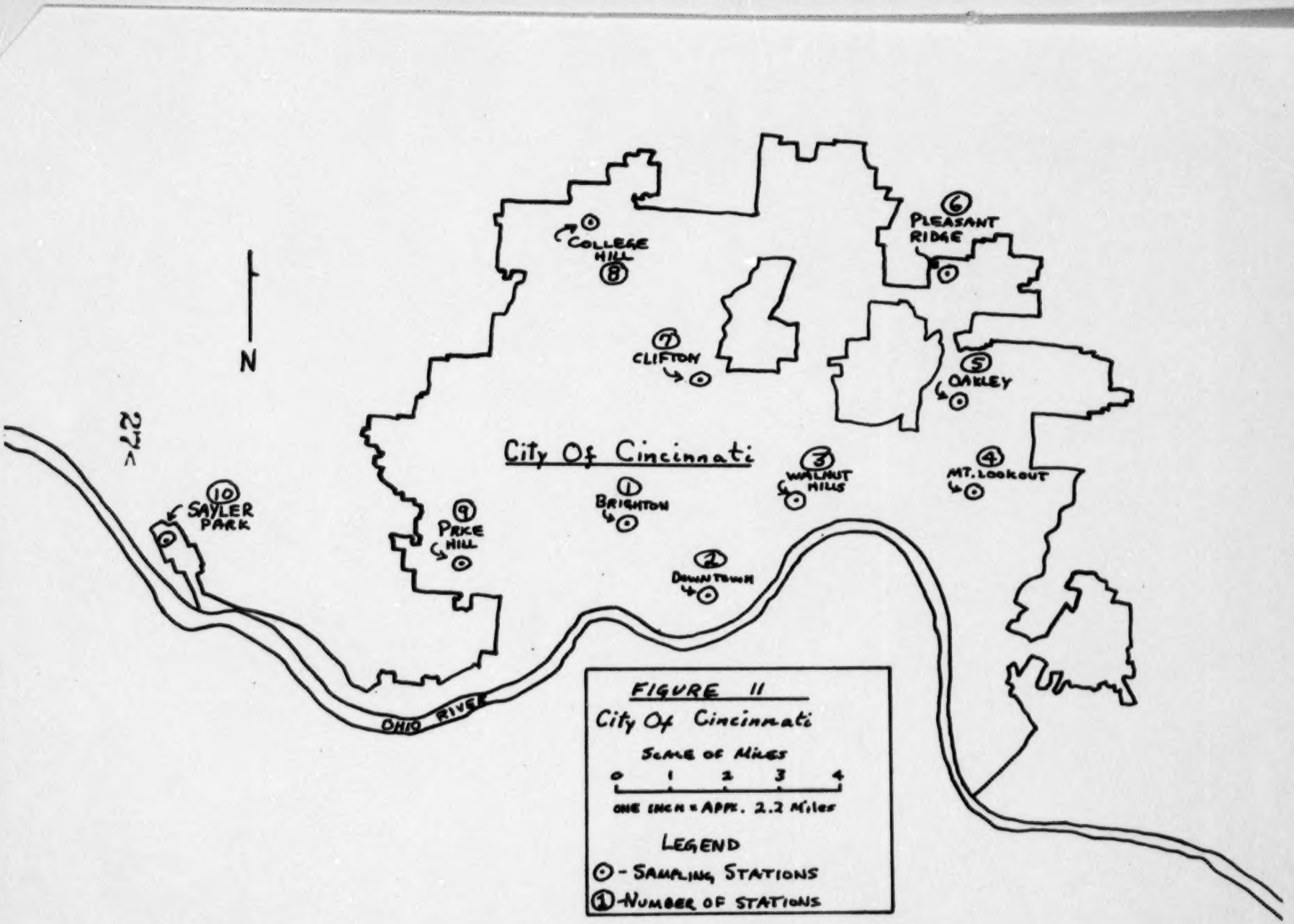


FIGURE 10
DUST FALL CONTAINER AND ADHESIVE IMPACTOR


N
275
City Of Cincinnati
COLLEGE HILL
8
PLEASANT RIDGE
6
CLIFTON
7
OAKLEY
5
WALNUT HILLS
3
MT. LOOKOUT
4
BRIGHTON
1
PRICE HILL
9
SAYLER PARK
10
DOWNTOWN
2
OHIO RIVER
FIGURE 11
City Of Cincinnati
Scale of Miles
0 1 2 3 4
ONE INCH = APPX. 2.2 Miles
LEGEND
⊙ - SAMPLING STATIONS
① - NUMBER OF STATIONS

August, 1967 Totals - Wind-blown vs. Settleable Particulates*

| LOCATION | AREA CLASS** | N | NE | E | SE | S | SW | W | NW | TOTAL | TOP | SETTLEABLE PARTICULATES (Tons per square mile) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 particles per square inch per week - monthly average) | | | | | | | | | | |
| College Hill | AC | 14 | 30 | 10 | 3 | 7 | 18 | 10 | 2 | 95 | 51 | 5.2 |
| Clifton | AB | 17 | 9 | 1 | 0 | 5 | 14 | 3 | 0 | 50 | 85 | 7.3 |
| Mt. Lookout | AA | 7 | 6 | 9 | 9 | 13 | 12 | 9 | 11 | 77 | 92 | 6.0 |
| Pleas. Ridge | AC | 20 | 54 | 52 | 47 | 31 | 20 | 33 | 26 | 286 | 90 | 6.7 |
| Price Hill | AC | 30 | 31 | 22 | 18 | 19 | 72 | 63 | 17 | 272 | 96 | 8.5 |
| Sayler Park | AC | 12 | 10 | 6 | 2 | 15 | 27 | 15 | 11 | 102 | 105 | 6.5 |
| Walnut Hills | CB | 122 | 106 | 27 | 35 | 46 | 54 | 96 | 101 | 590 | 164 | 9.6 |
| Oakley | EB | 103 | 98 | 124 | 76 | 54 | 44 | 56 | 100 | 657 | 238 | 13.4 |
| Downtown | DF | 158 | 128 | 57 | 59 | 90 | 239 | 286 | 100 | 1116 | 245 | 17.6 |
| Brighton | FC | 64 | 97 | 126 | 99 | 257 | 298 | 135 | 119 | 1196 | 360 | 21.9 |



* The above table was taken from Progres Report No. 3

** Area Class:
A - Residential, low density
B - Residential, high density
C - Commercial, neighborhood shopping district
D - Commercial, central business district
E - Industrial, low air pollution potential
F - Industrial, air pollution potential

Primary (first) classification indicates character of occupancy within 1/4 mile of sampling station; secondary classification indicates other occupancy within 1/2 mile of station.

TABLE 5

September, 1967 totals - Wind-blown vs. Settleable Particulates

| LOCATION | AREA CLASS* | N | NE | E | SE | S | SW | W | NW | TOTAL TOP | SETTLEABLE PARTICULATES (Tons per square mile) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 Particles per square inch per week - monthly average) | | | | | | | | | |
| College Hill | AC | 23 | 21 | 19 | 15 | 21 | 26 | 10 | 4 | 139 94 | 7.2 |
| Clifton | AB | 23 | 21 | 9 | 3 | 8 | 9 | 6 | 5 | 84 123 | 9.4 |
| Mt. Lookout | AA | 15 | 9 | 10 | 9 | 13 | 18 | 21 | 17 | 112 110 | 9.1 |
| Pleas. Ridge | AC | 54 | 31 | 35 | 68 | 48 | 18 | 23 | 81 | 358 80 | 7.7 |
| Price Hill | AC | 41 | 44 | 59 | 40 | 35 | 61 | 59 | 26 | 365 170 | 10.8 |
| Sayler Park | AC | 4 | 3 | 6 | 3 | 13 | 23 | 10 | 3 | 65 53 | 7.6 |
| Walnut Hills | CB | 62 | 32 | 19 | 49 | 64 | 49 | 57 | 49 | 381 142 | 10.0 |
| Oakley | EB | 102 | 121 | 146 | 64 | 59 | 40 | 63 | 141 | 736 199 | 17.9 |
| Downtown | DF | 121 | 114 | 31 | 63 | 108 | 175 | 160 | 76 | 848 210 | 18.0 |
| Brighton | FC | 61 | 88 | 179 | 130 | 289 | 290 | 121 | 112 | 1270 390 | 24.7 |

* Area Class:
A - Residential, low density
B - Residential, high density
C - Commercial, neighborhood shopping district
D - Commercial, Central Business district
E - Industrial, low air pollution potential
F - Industrial, air pollution potential

Primary (first) classification indicates character of occupancy within 1/4 mile of sampling station; secondary classification indicates other occupancy within 1/2 mile of station.

TABLE 6

May, 1968 Totals - Wind-Blown vs. Settleable Particulates

| LOCATION | AREA CLASS* | N | NE | E | SE | S | SW | W | NW | TOTAL TOP | SETTLEABLE PARTICULATES (Tons per square mile) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 Particles per square inch per week - monthly average) | | | | | | | | | |
| College Hill | AC | 0 | 10 | 20 | 20 | 20 | 70 | 50 | 40 | 230 40 | 11.7 |
| Clifton | AB | 0 | 10 | 0 | 0 | 0 | 30 | 30 | 10 | 80 60 | 11.4 |
| Mt. Lookout | AA | 30 | 20 | 50 | 40 | 50 | 60 | 40 | 50 | 340 150 | 11.7 |
| Pleas. Ridge | AC | 60 | 60 | 60 | 120 | 170 | 110 | 40 | 20 | 640 130 | 12.9 |
| Price Hill | AC | 40 | 40 | 50 | 30 | 50 | 170 | 180 | 60 | 620 110 | 13.8 |
| Sayler Park | AC | 20 | 30 | 20 | 30 | 30 | 50 | 40 | 30 | 250 80 | 15.1 |
| Walnut Hills | CB | 100 | 40 | 30 | 60 | 90 | 130 | 240 | 170 | 860 130 | 17.3 |
| Oakley | EB | 160 | 80 | 90 | 100 | 90 | 110 | 90 | 170 | 890 200 | 21.9 |
| Downtown | DF | 120 | 60 | 50 | 70 | 150 | 370 | 230 | 120 | 1170 190 | 22.7 |
| Brighton | FC | 170 | 80 | 180 | 160 | 270 | 380 | 320 | 290 | 1850 260 | 32.8 |



*Area Class:
- A - Residential, low density
- B - Residential, high density
- C - Commercial, neighborhood shopping district
- D - Commercial, central business district
- E - Industrial, low air pollution potential
- F - Industrial, air pollution potential

Primary (first) classification indicates character of occupancy within 1/4 mile of sampling station; secondary classification indicates other occupancy within 1/2 mile of station.

TABLE 7

June, 1968 Totals - Wind-blown vs. Settleable Particulates

| LOCATION | AREA CLASS* | N | NE | E | SE | S | SW | W | NW | TOTAL TOP | | SETTLEABLE PARTICULATES (Tons per square mile) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 Particles per square inch per week - monthly average) | | | | | | | | | | |
| College Hill | AC | 20 | 10 | 0 | 10 | 30 | 60 | 70 | 40 | 240 | 60 | 9.7 |
| Clifton | AB | 3 | 3 | 3 | 13 | 13 | 26 | 16 | 3 | 80 | 80 | 11.6 |
| Mt. Lookout | AA | 30 | 40 | 20 | 20 | 20 | 50 | 30 | 30 | 240 | 120 | 11.6 |
| Pleas. Ridge | AC | 40 | 70 | 70 | 100 | 170 | 150 | 80 | 50 | 730 | 190 | 10.1 |
| Price Hill | AC | 30 | 30 | 40 | 50 | 40 | 80 | 200 | 150 | 620 | 190 | 13.6 |
| Sayler Park | AC | 20 | 0 | 0 | 10 | 40 | 30 | 20 | 20 | 140 | 70 | 9.8 |
| Walnut Hills | CB | 140 | 80 | 40 | 50 | 90 | 140 | 180 | 170 | 890 | 150 | 12.7 |
| Oakley | EB | 210 | 120 | 130 | 110 | 90 | 130 | 120 | 120 | 1030 | 260 | 20.6 |
| Downtown | DF | 180 | 100 | 80 | 80 | 120 | 350 | 310 | 130 | 1350 | 290 | 18.2 |
| Brighton | FC | 170 | 110 | 170 | 160 | 320 | 480 | 370 | 340 | 2120 | 460 | 29.8 |

*Area Class:
A - Residential, low density
B - Residential, high density
C - Commercial, neighborhood shopping district
D - Commercial, central business district
E - Industrial, low air pollution potential
F - Industrial, air pollution potential

Primary (first) classification indicates character of occupancy within 1/4 mile of sampling station; secondary classification indicates other occupancy within 1/2 mile of station.

TABLE 8

July, 1968 Totals - Wind-blown vs. Settleable Particulates

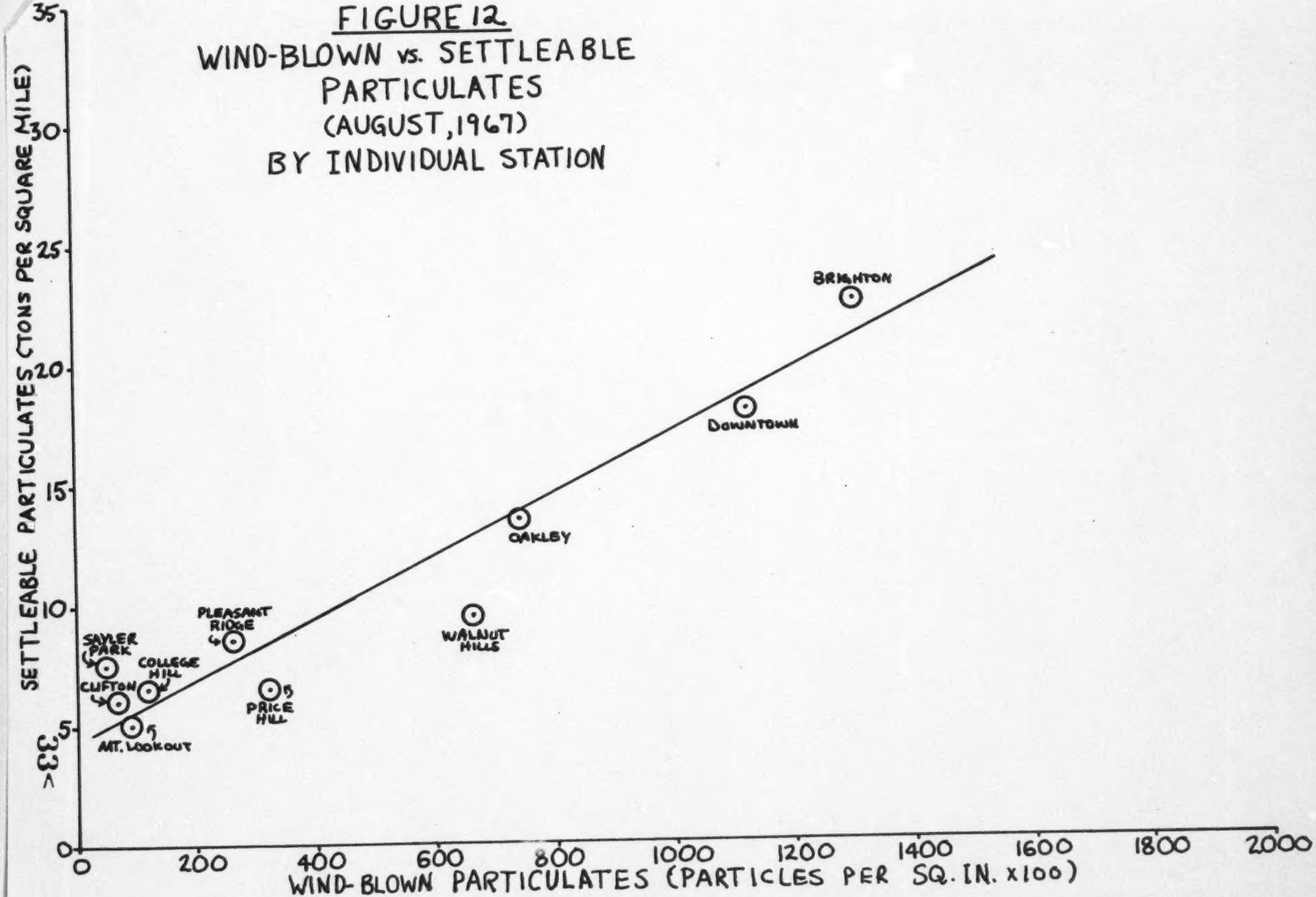
| LOCATION | AREA CLASS* | N | NE | E | SE | S | SW | W | NW | TOTAL TOP | | SETTLEABLE PARTICULATES (Tons per square mile) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (100 Particles per square inch per week - monthly average) | | | | | | | | | | |
| College Hill | AC | 10 | 30 | 20 | 20 | 30 | 50 | 40 | 20 | 220 | 60 | 10.6 |
| Clifton | AB | 4 | 4 | 4 | 4 | 8 | 4 | 4 | 4 | 40 | 60 | 13.9 |
| Mt. Lookout | AA | 40 | 30 | 30 | 10 | 10 | 20 | 20 | 30 | 190 | 70 | 8.6 |
| Pleas. Ridge | AC | 40 | 40 | 40 | 80 | 110 | 60 | 50 | 30 | 450 | 110 | 10.5 |
| Price Hill | AC | 40 | 40 | 40 | 40 | 40 | 40 | 90 | 50 | 380 | 80 | 10.3 |
| Sayler Park | AC | 11 | 11 | 11 | 11 | 11 | 21 | 21 | 11 | 110 | 70 | 6.9 |
| Walnut Hills | CB | 50 | 40 | 40 | 50 | 50 | 50 | 70 | 70 | 420 | 100 | 10.2 |
| Oakley | EB | 90 | 60 | 50 | 50 | 50 | 80 | 70 | 70 | 520 | 110 | 9.7 |
| Downtown | DF | 100 | 40 | 40 | 50 | 80 | 140 | 140 | 80 | 670 | 180 | 14.1 |
| Brighton | FC | 110 | 60 | 120 | 140 | 90 | 230 | 210 | 140 | 1100 | 300 | 36.6 |

*Area Class:
A - Residential, low density
B - Residential, high density
C - Commercial, neighborhood shopping district
D - Commercial, central business district
E - Industrial, low air pollution potential
F - Industrial, air pollution potential

Primary (first) classification indicates character of occupancy within 1/4 mile of sampling station; secondary classification indicates other occupancy within 1/2 mile of station.

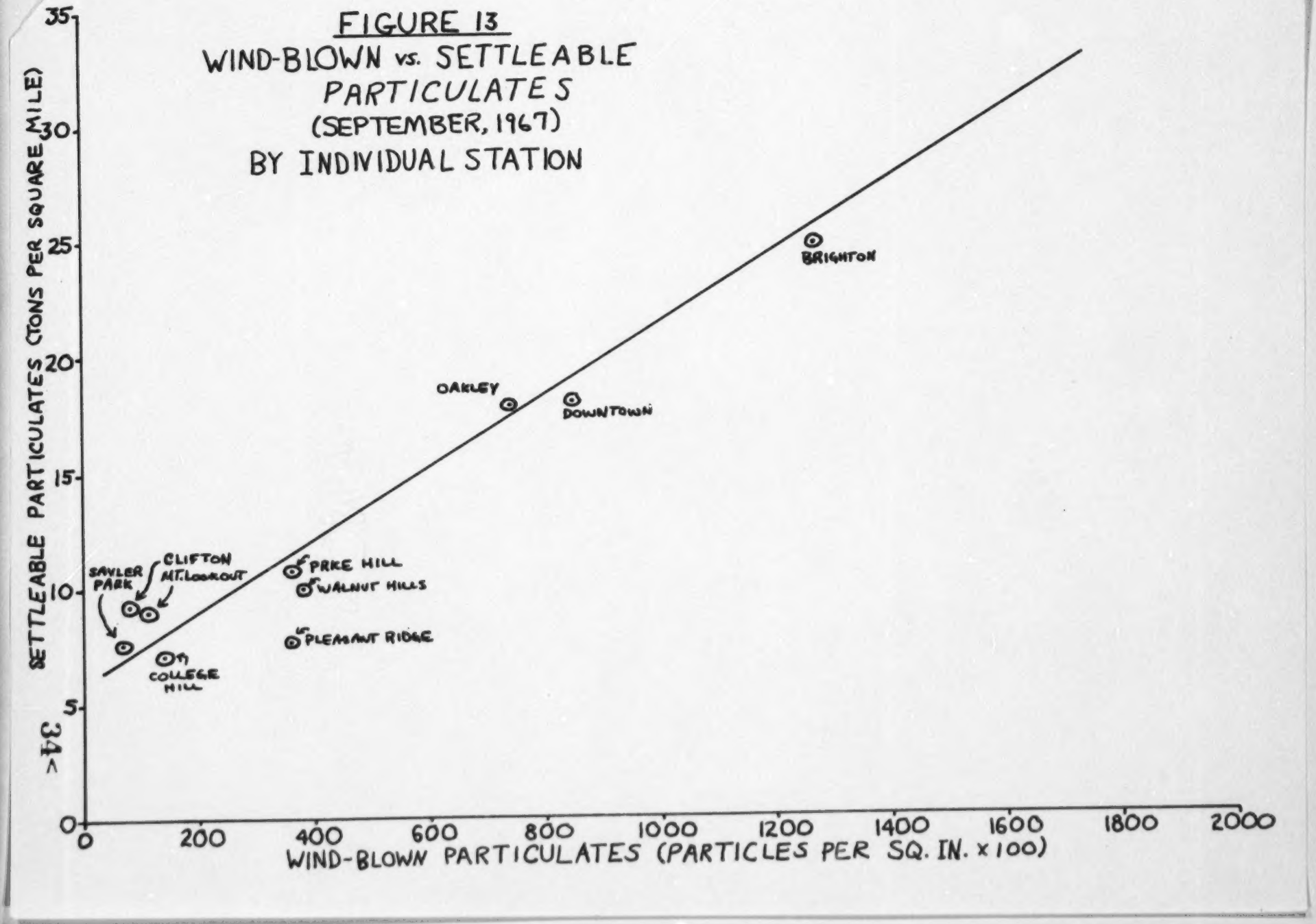
# FIGURE 12

## WIND-BLOWN vs. SETTLEABLE PARTICULATES (AUGUST, 1967) BY INDIVIDUAL STATION



# FIGURE 13

## WIND-BLOWN vs. SETTLEABLE PARTICULATES (SEPTEMBER, 1967) BY INDIVIDUAL STATION



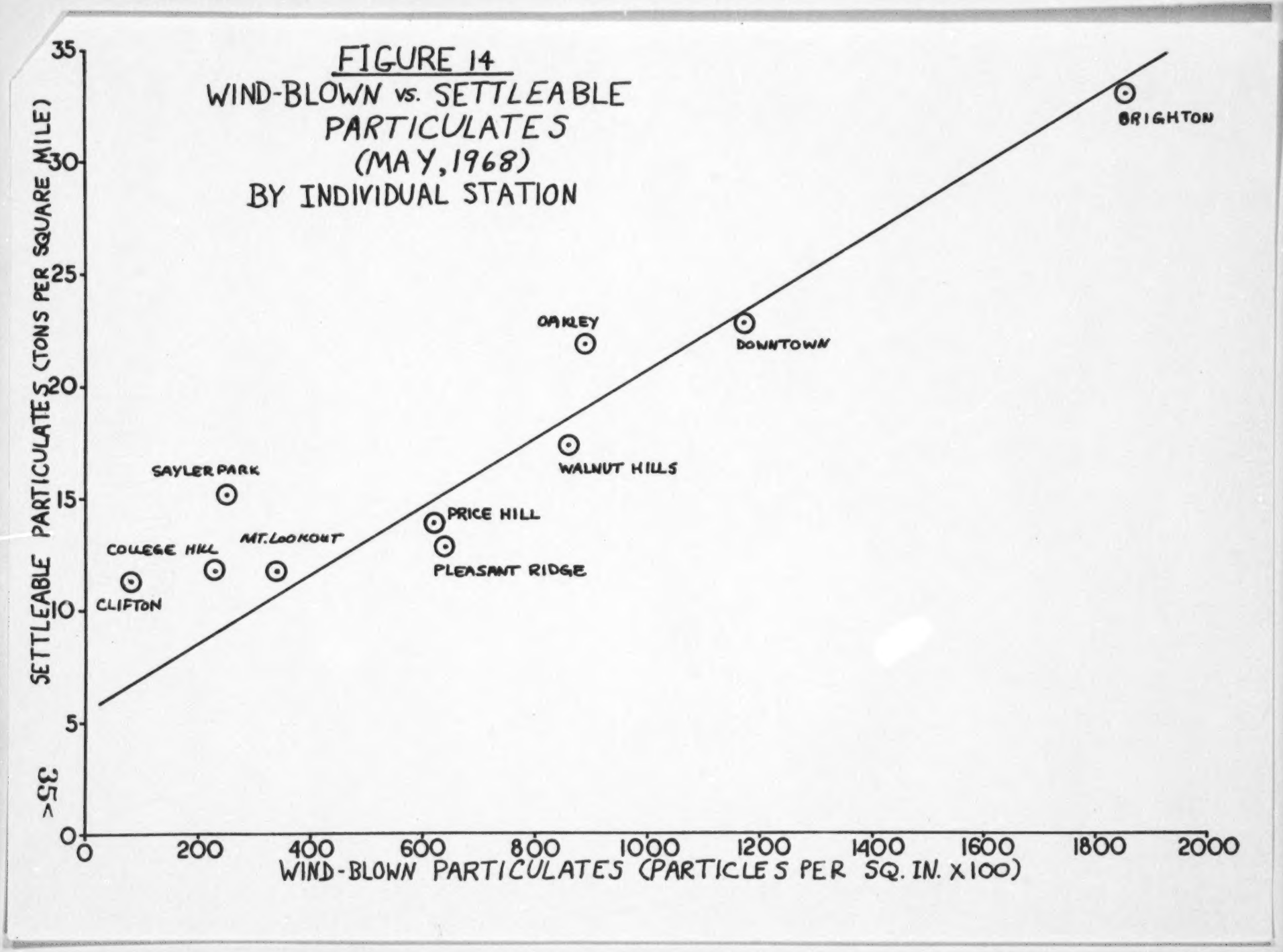


FIGURE 14
WIND-BLOWN vs. SETTLEABLE PARTICULATES (MAY, 1968) BY INDIVIDUAL STATION
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. X 100)
>35
0
5
10
15
20
25
30
35
0
200
400
600
800
1000
1200
1400
1600
1800
2000
BRIGHTON
OAKLEY
DOWNTOWN
WALNUT HILLS
SAYLER PARK
PRICE HILL
MT. LOOKOUT
COLLEGE HILL
PLEASANT RIDGE
CLIFTON

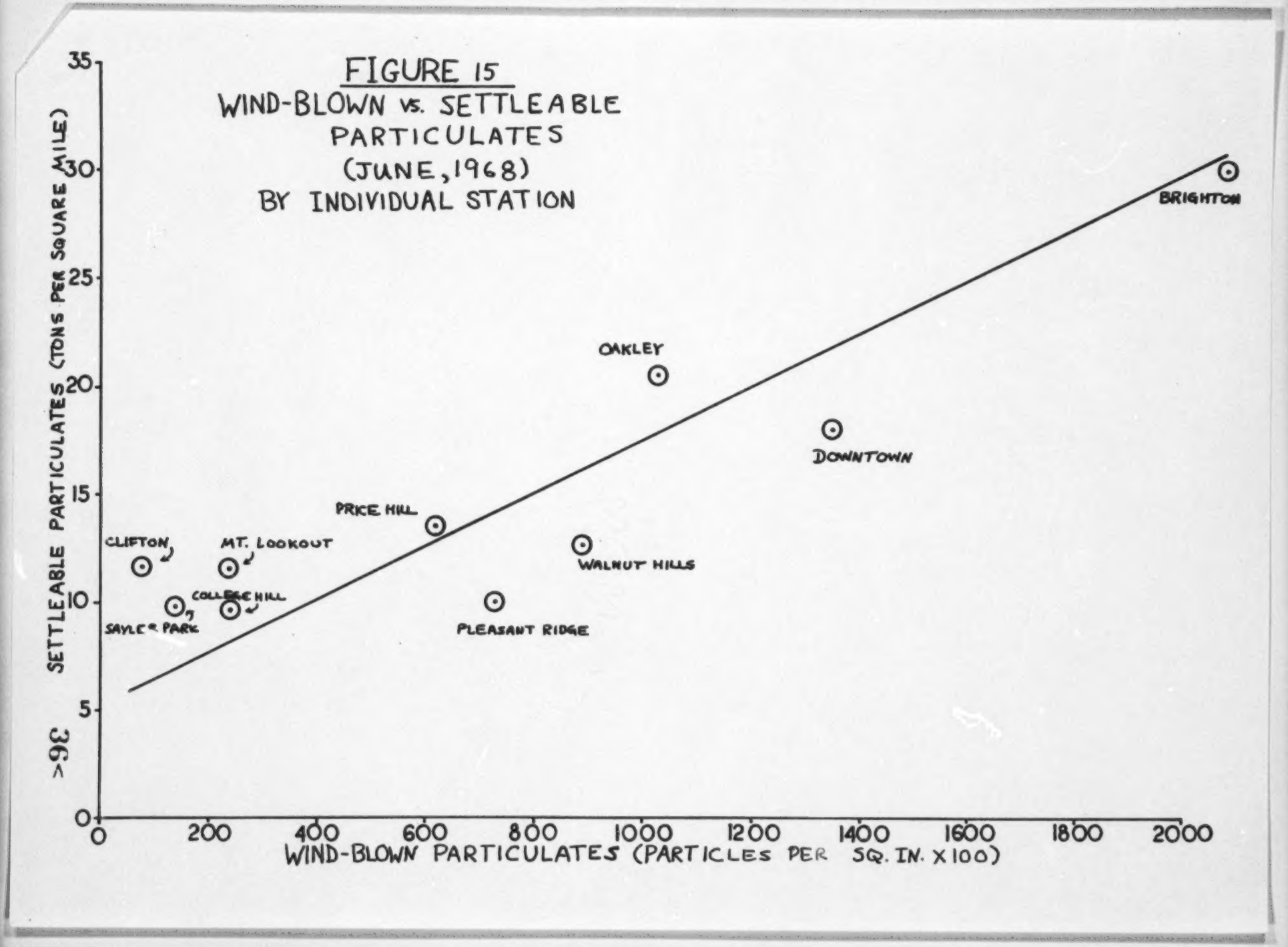


FIGURE 15
WIND-BLOWN VS. SETTLEABLE PARTICULATES (JUNE, 1968) BY INDIVIDUAL STATION
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. X 100)
0
5
10
15
20
25
30
35
0
200
400
600
800
1000
1200
1400
1600
1800
2000
BRIGHTON
OAKLEY
DOWNTOWN
PRICE HILL
CLIFTON
MT. LOOKOUT
WALNUT HILLS
COLLEGE HILL
SAYLER PARK
PLEASANT RIDGE

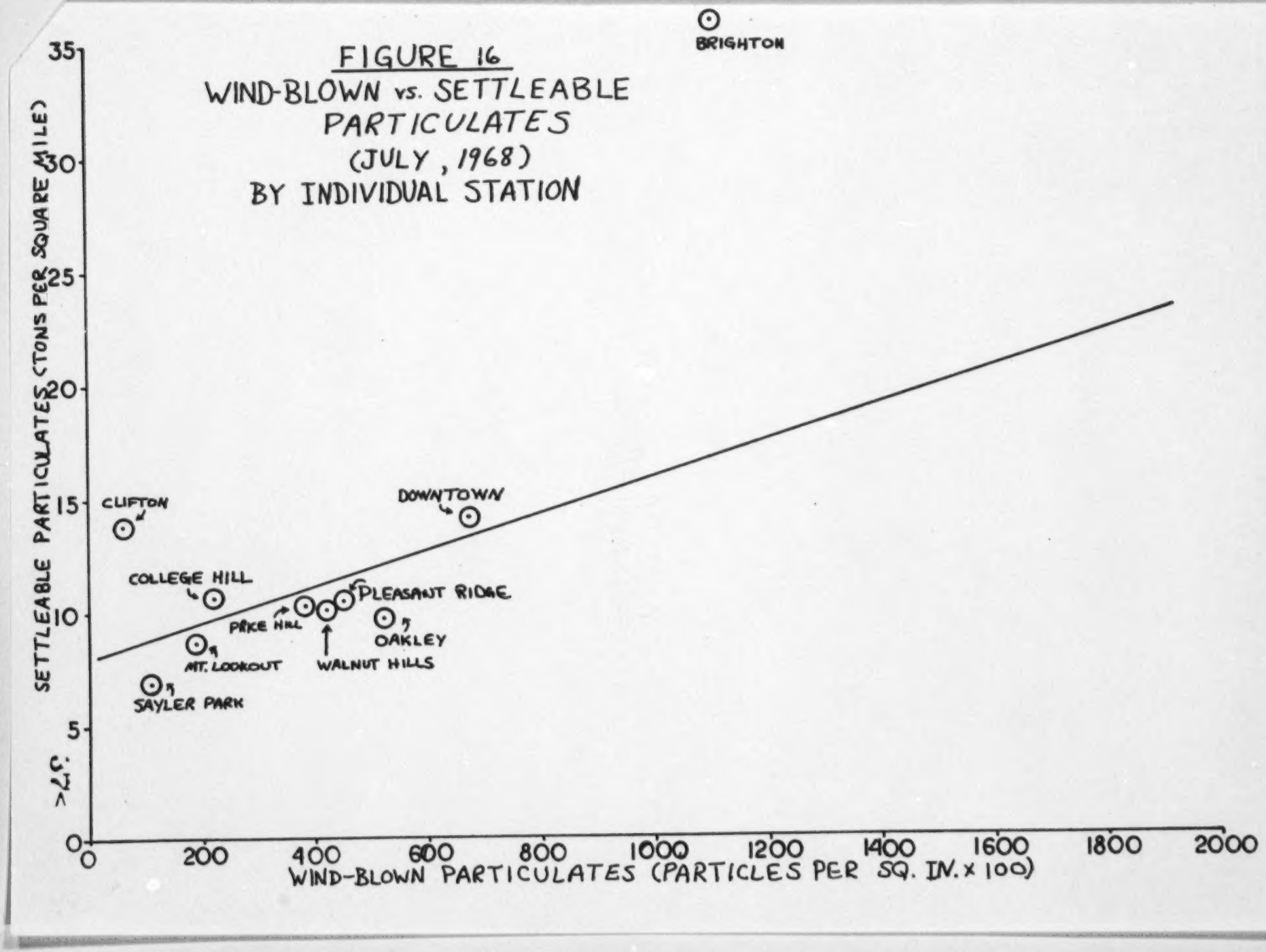


FIGURE 16
WIND-BLOWN vs. SETTLEABLE PARTICULATES (JULY, 1968) BY INDIVIDUAL STATION
BRIGHTON
CLIFTON
DOWNTOWN
COLLEGE HILL
PLEASANT RIDGE
PIKE HILL
OAKLEY
MT. LOOKOUT
WALNUT HILLS
SAYLER PARK
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. x 100)
0
5
10
15
20
25
30
35
200
400
600
800
1000
1200
1400
1600
1800
2000

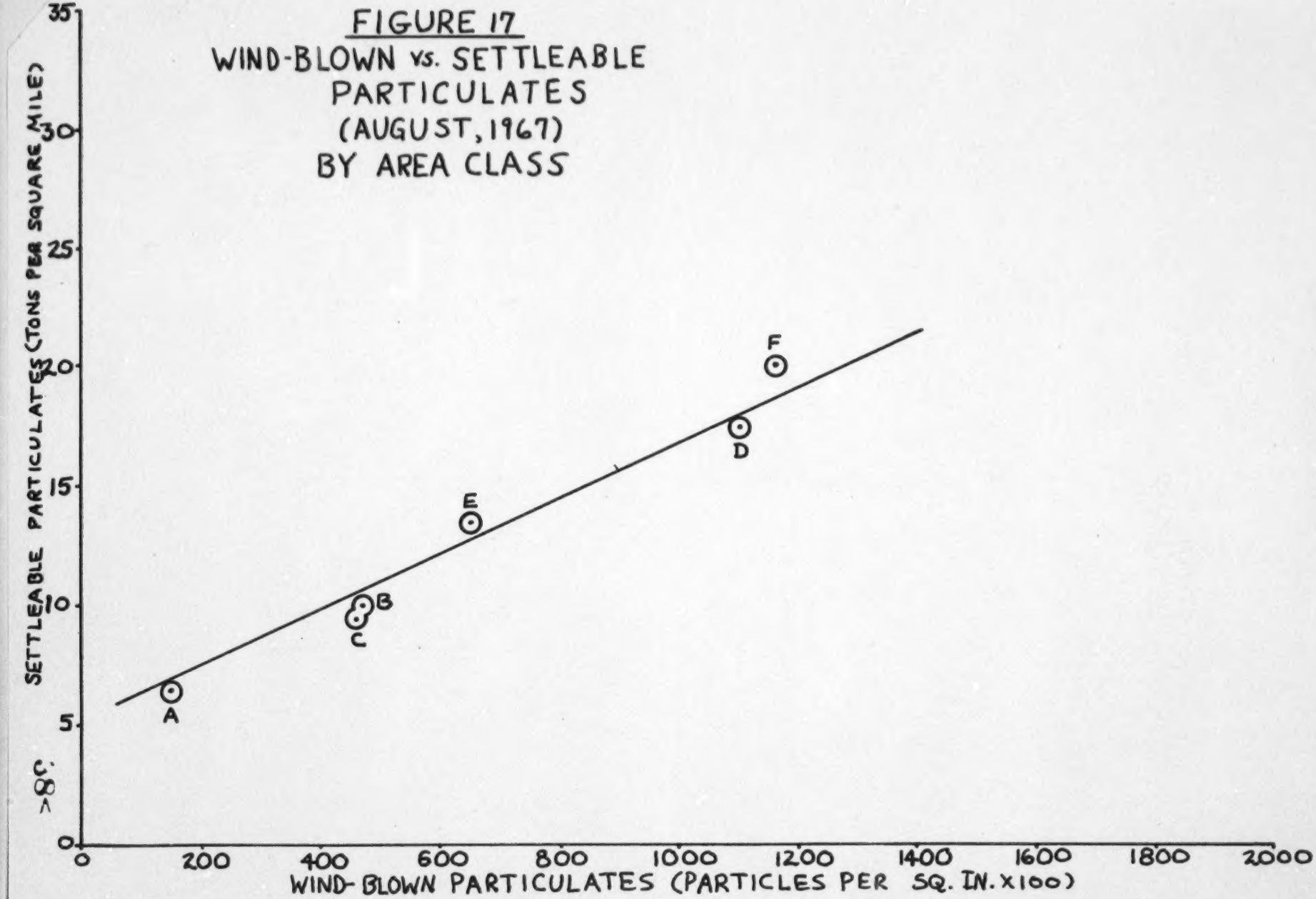
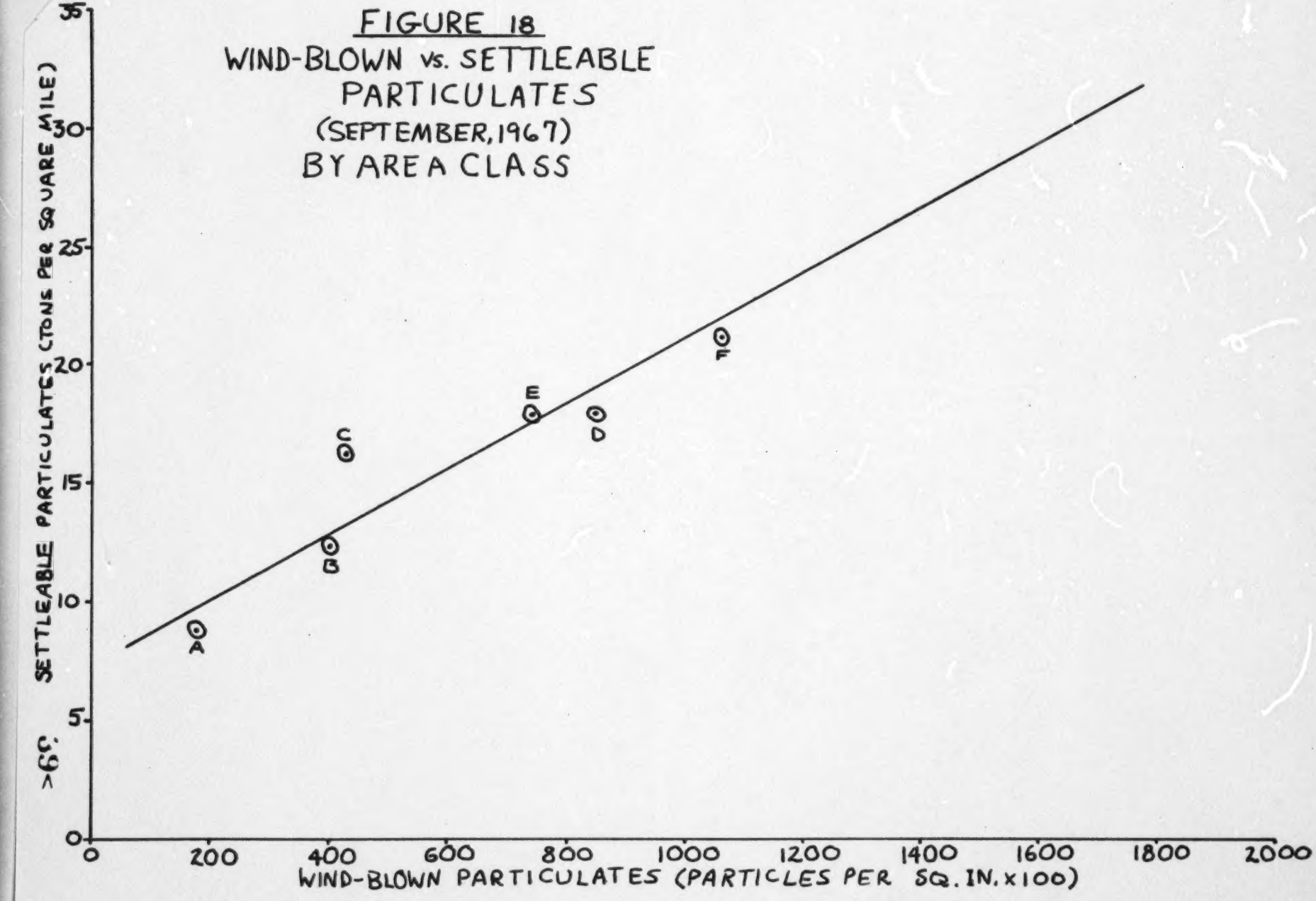


FIGURE 17
WIND-BLOWN vs. SETTLEABLE PARTICULATES (AUGUST, 1967) BY AREA CLASS
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
35
30
25
20
15
10
5
0
A
B
C
D
E
F
0
200
400
600
800
1000
1200
1400
1600
1800
2000
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. X100)

# FIGURE 18

## WIND-BLOWN vs. SETTLEABLE PARTICULATES (SEPTEMBER, 1967) BY AREA CLASS



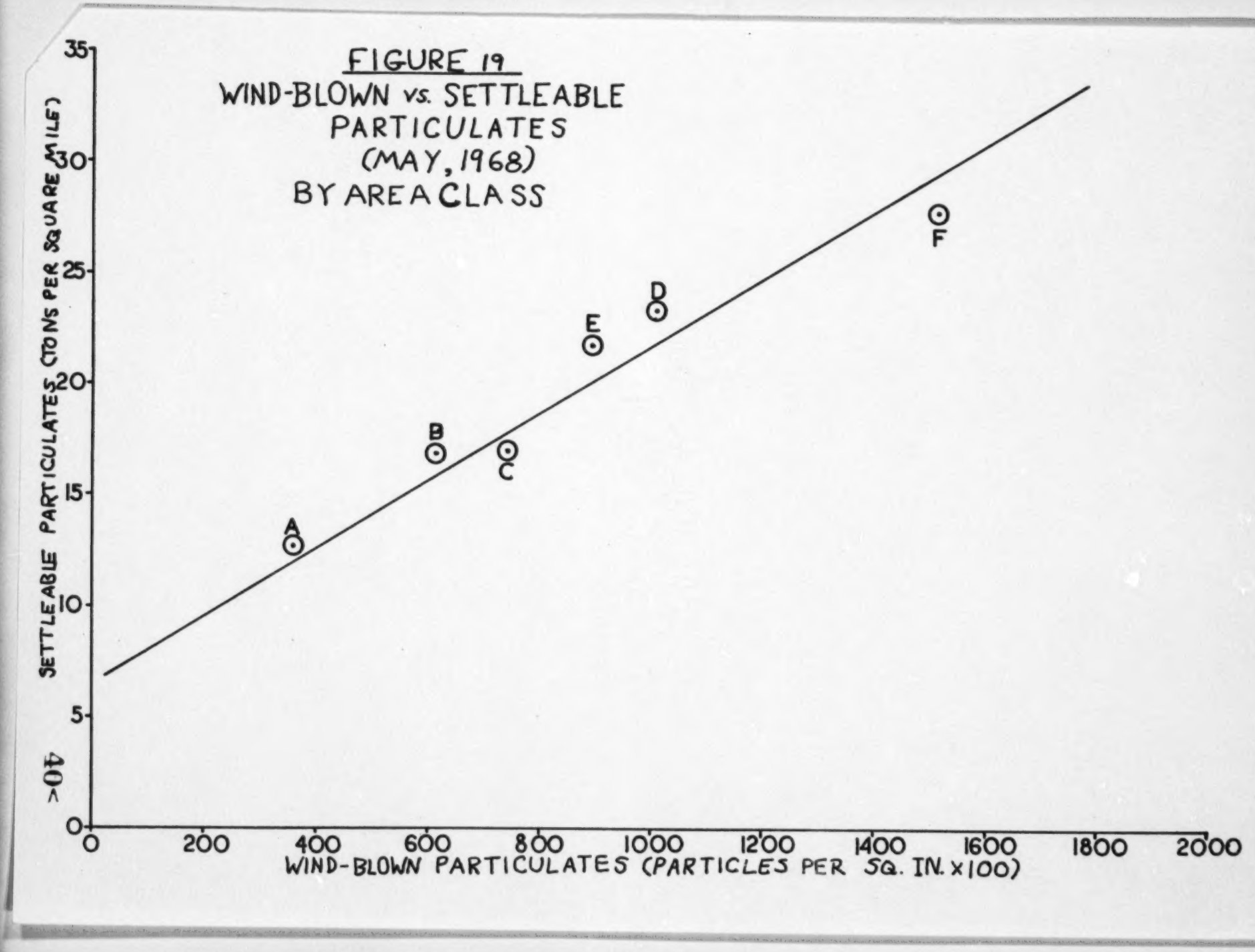
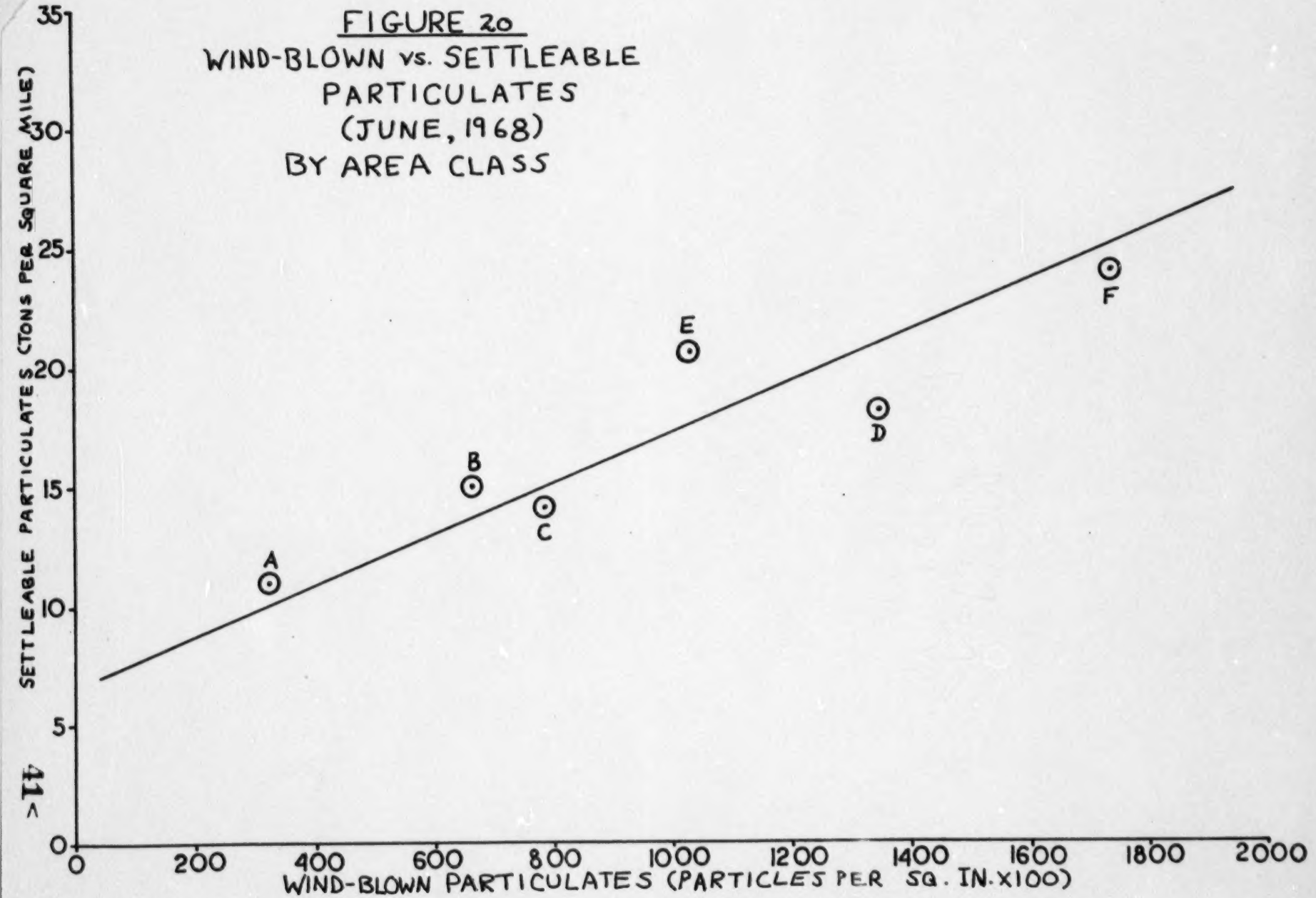


FIGURE 19
WIND-BLOWN vs. SETTLEABLE PARTICULATES (MAY, 1968) BY AREA CLASS
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. x100)
0
5
10
15
20
25
30
35
<40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
A
B
C
D
E
F

FIGURE 20

WIND-BLOWN vs. SETTLEABLE PARTICULATES (JUNE, 1968) BY AREA CLASS



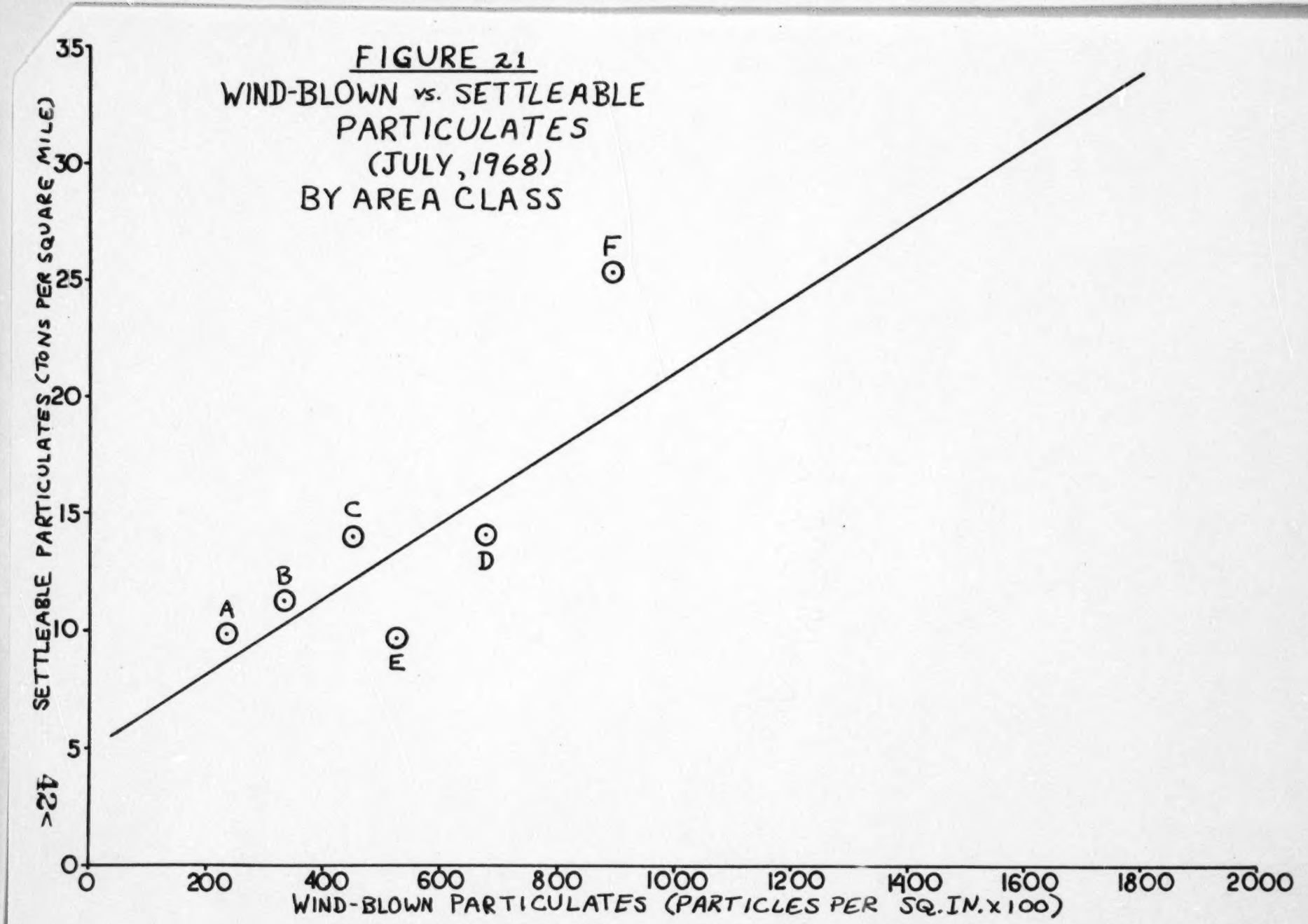
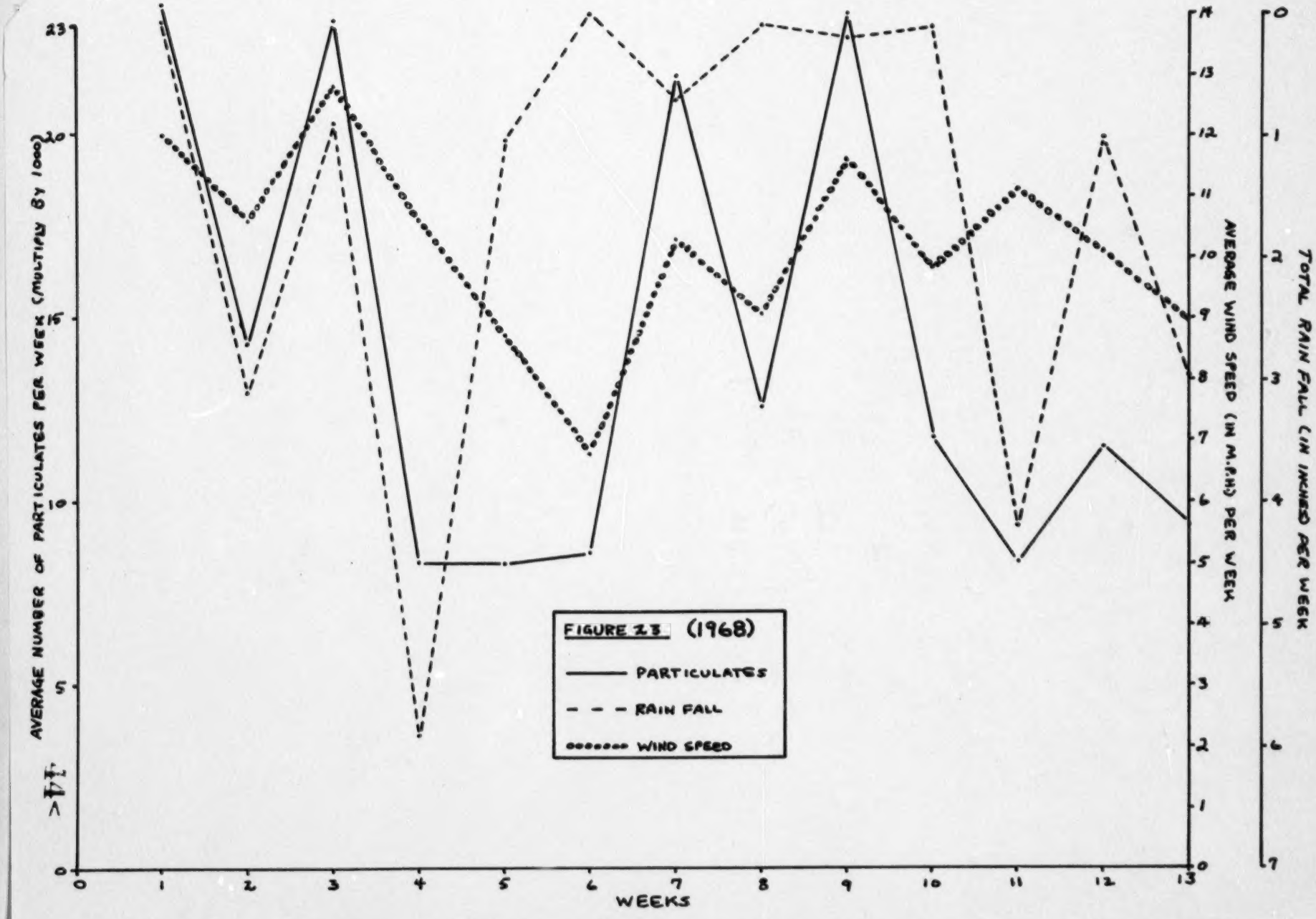


FIGURE 21
WIND-BLOWN vs. SETTLEABLE PARTICULATES (JULY, 1968) BY AREA CLASS
SETTLEABLE PARTICULATES (TONS PER SQUARE MILE)
>42
35
30
25
20
15
10
5
0
A
B
C
D
E
F
0
200
400
600
800
1000
1200
1400
1600
1800
2000
WIND-BLOWN PARTICULATES (PARTICLES PER SQ. IN. x 100)

TOTAL RAINFALL (IN INCHES) PER WEEK
0
1
2
3
4
5
6
7
AVERAGE WIND SPEED (IN M.P.H.) PER WEEK
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
WEEKS
0
1
2
3
4
5
6
7
8
9
AVERAGE NUMBER OF PARTICULATES PER WEEK (MULTIPLY BY 1000)
23
20
15
10
5
0
FIGURE 22 (1967)
PARTICULATES
RAIN FALL
WIND SPEED


AVERAGE NUMBER OF PARTICULATES PER WEEK (MULTIPLY BY 1000)
AVERAGE WIND SPEED (IN M.P.H.) PER WEEK
TOTAL RAIN FALL (IN INCHES) PER WEEK
WEEKS
FIGURE 23 (1968)
PARTICULATES
RAIN FALL
WIND SPEED